



Adsorption of soy isoflavones by activated carbon: Kinetics, thermodynamics and influence of soy oligosaccharides

Yun Shi, Xiangzhen Kong, Caimeng Zhang, Yeming Chen, Yufei Hua *

State Key Laboratory of Food Science and Technology, Jiangnan University, Wuxi, 1800 Lihu Avenue, Jiangsu Province, PR China
School of Food Science and Technology, Jiangnan University, Wuxi, 1800 Lihu Avenue, Jiangsu Province, PR China

HIGHLIGHTS

- Systematic studied the adsorption of soy isoflavones by activated carbon.
- The adsorption characters vary with the chemical forms of soy isoflavones.
- The adsorption of soy isoflavones by activated carbon is endothermic.
- Soy oligosaccharides have negative influence to the diffusion of isoflavones.

ARTICLE INFO

Article history:

Received 12 September 2012
Received in revised form 10 October 2012
Accepted 11 October 2012
Available online 10 November 2012

Keywords:

Adsorption
Activated carbon
Isoflavones
Soy molasses

ABSTRACT

Adsorption behavior of daidzin, genistin, 6''-O-malonyldaidzin and 6''-O-malonylgenistin, the four major soy isoflavones presented in soy molasses centrifugation supernatant on activated carbon was studied in this paper so as to provide theoretical basis for the purification of soy oligosaccharides from soy molasses. Kinetic experiments showed that the adsorption processes obeyed pseudo-second-order kinetics and equilibrium was nearly achieved in 90 min. Weber–Morris model fitting showed that adsorption process consisted of 3 stages: boundary layer diffusion and two intra-particle diffusions. Experimental adsorption data for every isoflavone components could be described separately by the Langmuir isotherm model and the calculated maximum adsorptions were in the order of genistin > daidzin > 6''-O-malonylgenistin > 6''-O-malonyldaidzin, indicating that the adsorption driving forces were due to dispersion interactions between the aromatic ring of isoflavone and the aromatic structure of the activated carbon. Adsorption behaviors of isoflavones on activated carbon in sugar free solutions were compared. It was found that, by removing sugar from the system, diffusion rate constants and the sum of the maximum adsorption capacity increased.

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1. Introduction

Soy molasses is a by-product generated in the production of soy protein concentrate, in which soy oligosaccharides, isoflavones, saponins, and other phytochemicals are enriched [1,2]. The by-product has been a popular fermentation medium for bio-ethanol [3] as well as lactic acid [4] production and a good resource of soybean phytochemicals. Several researchers reported isolating isoflavones and other phytochemicals from the insoluble precipitates of soy molasses suspension [5–7] while there are few reports concerned with the centrifugation supernatant of soy molasses. The supernatant contains most of the water soluble com-

ponents existed in soy molasses, predominantly sucrose, raffinose and stachyose. Raffinose and stachyose have been proved to be functional oligosaccharides, as they can stimulate the growth of bifidobacteria and other kinds of lactic acid bacteria, promote the competitive exclusion of potential pathogens [8] and reduce the levels of some colonic enzymes (β -glucuronidase, nitroreductase, azoreductase and glycolic acid hydrolase) which are implicated in the conversion of procarcinogens to carcinogens [9].

Currently, commercial soy oligosaccharides are isolated from soybean whey which is generated from soy protein isolate production [10]. Extraction of soy oligosaccharides from soy molasses supernatant could be more beneficial economically because of its higher oligosaccharide concentration, thus less energy is needed in water evaporation. As Galanakis [11] pointed out, recovery of high-added value compounds usually follows 4–5 stages of macroscopic pretreatment, macro- and micro-molecules separation, extraction, isolation and purification, as well as finally product

* Corresponding author at: State Key Laboratory of Food Science and Technology, School of Food Science and Technology, Jiangnan University, Wuxi 214122, 1800 Lihu Avenue, Jiangsu Province, PR China. Tel./fax: +86 510 85917812.

E-mail address: yfhua@yahoo.com.cn (Y. Hua).